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**Author post-print (accepted) deposited in CURVE February 2016**

**Original citation & hyperlink:**

Nowak, J. , Nowak, B. and Kaczmarek, M. (2015) Skinfold creep under load of caliper. Linear visco-and poroelastic model simulations. ACTA OF BIOENGINEERING AND BIOMECHANICS, volume 17 (4)

<http://dx.doi.org/10.5277/ABB-00128-2014-04>

ISSN 1509-409X

DOI 10.5277/ABB-00128-2014-04

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**Skinfold creep under load of caliper. Linear visco-and poroelastic model simulations**Joanna Nowak<sup>1\*</sup>, Bartosz Nowak<sup>2</sup>, Mariusz Kaczmarek<sup>1</sup><sup>1</sup>Institute of Mechanics and Applied Computer Science, Kazimierz Wielki University  
Bydgoszcz, Poland<sup>2</sup>Faculty of Civil Engineering, Bauhaus-Universität Weimar, Weimar, Germany**Abstract**

**Purpose:** This paper refers to the diagnostic idea proposed in [11] to measure the parameter called rate of creep of axillary fold of tissue using modified Harpenden skinfold caliper in order to distinguish normal and edematous tissue. Our simulations are intended to help understanding the creep phenomenon and creep rate parameter as a sensitive indicator of edema existence. The parametric analysis shows the tissue behavior under the external load as well as its sensitivity to changes of crucial hydro-mechanical tissue parameters e.g. permeability or stiffness.

**Methods:** The linear viscoelastic and poroelastic models of normal (single phase) and oedematous tissue (two - phase: swelled tissue with excess of interstitial fluid) implemented in COMSOL Multiphysics environment are used. Simulations are performed within the range of small strains for a simplified fold geometry, material characterization and boundary conditions. The predicted creep is the result of viscosity (viscoelastic model) or pore fluid displacement (poroelastic model) in tissue.

**Results:** The tissue deformations, interstitial fluid pressure as well as interstitial fluid velocity are discussed in parametric analysis with respect to elasticity modulus, relaxation time or permeability of tissue. The creep rate determined within the considered models of tissue is compared and referred to the diagnostic idea in [11].

**Conclusion:** The results obtained from the two linear models of subcutaneous tissue indicate that the form of creep curve and the creep rate are sensitive to material parameters which characterize the tissue. However the adopted modelling assumptions point on a limited applicability of the creep rate as the discriminant of oedema.

**Keywords:** computer simulations, soft tissue, lymphoedema, viscoelasticity, poroelasticity, modeling